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From: **Steve Thurston** <thurston.steve@gmail.com>
Date: Wed, May 6, 2009 at 1:25 PM
Subject: Additional testimony Record Hill Wind LLC - noise
To: Beth.Callahan@maine.gov
Cc: "Dr. Dora Anne Mills" <dora.a.mills@maine.gov>, Warren_Brown@umit.maine.edu

Dear Beth,

Having read the decisions on the Stetson II and Rollins projects I feel the need to submit additional testimony into the record regarding noise. Please acknowledge receipt of this email and the pdf attachment containing exhibits A through H referenced in the following narrative. For their convenience I have CC'd Warren Brown and Dr. Dora Mills. Please confirm with them that their response is needed to complete your findings of fact.

Thanks very much,
Steve

The failure of both the Stetson II and Rollins decisions to address three major issues that are of paramount importance is extremely problematic, both in legal terms, in that the findings of fact and conclusion did not address important testimony that was submitted into the record, and in practical terms, in that the failure to properly predict noise levels merely repeats the experience at Mars Hill, where measured turbine noise in excess of Maine's noise limits has been found to be 10 decibels or more higher than the model predicted. The three issues are:

1. The application of a **5 dB penalty** for the notorious short duration repetitive (SDR) "thumping" sound which is the hallmark of wind turbine noise complaints around the world.
2. The necessity of accurate prediction of **low frequency noise levels** and the requirement that all components of turbine noise remain within MDEP limits, instead of simply averaging all bandwidths to "mask" the intensity of the low frequency noise.
3. The necessity of using **line source as well as point source** in the noise prediction model.

1. SDR penalty

Warren Brown recommended that the SDR penalty be imposed in the Rollins application but instead of respecting the opinion of the third party expert hired to advise the department, the department allowed the developer to ignore this fundamental rule of noise propagation in the prediction model. As Richard James pointed out in the testimony I submitted at the DEP hearing in Rumford, there is ample evidence that the SDR thumping sound can be expected to exceed 10 dB, and in fact the Mars Hill post construction noise study proves the point.

The data from the RSE post construction noise monitoring at Mars Hill, Sept. 5, 2008

Figure 7-1, (Exhibit A) clearly shows nearly +7 dBA amplitude modulation "peaks" even at 5 second measurement intervals. As Richard James points out in his analysis of the data, a measurement interval of .125 (Lfast) would add 6 dB or more to the peak to trough levels during amplitude modulation. (Exhibit B)

The thumping sound is the primary complaint of Mars Hill residents. It penetrates the walls of their homes even when their own noise meters show less than 45 bBA outside their homes. The reason for this is that the SDR noise from turbines is low frequency noise that is discounted to a degree on the dBA bandwidth. If dBC bandwidth was used the thumping noise would show a higher measurement, since atmospheric attenuation of low frequencies is much less than higher frequencies. Given the seriousness of the turbine SDR noise complaints at Mars Hill, there was no basis for the department to ignore Warren Brown's concerns in the Rollins decision, nor should the DEP ignore this evidence in the RHW LLC application.

As is noted in the Rollins decision, the application of the SDR 5dB penalty could put the predicted noise levels above the 45 dBA nighttime limit at some protected locations:

EnRad recommends further evaluation for excessive amplitude modulation and potential SDR sound that might trigger application of the 5 dBA penalty to be applied to measured or modeled sound levels. If SDR sounds occur for a significantly large percentage of time, application of the 5 dBA penalty could result in locations with measured sound levels of 43 dBA or greater exceeding the 45 dBA limit for periods of the SDR sound event.

Instead of heeding this damning evidence, the DEP chose to ignore it in favor of post construction noise studies and a "compliance plan". There is no mitigation available for this thumping sound, as has been shown at Mars Hill. Once the project is constructed no compliance plan will eliminate this noise component of turbine operation unless the turbines can be automatically controlled by wind or noise sensors placed at appropriate locations.

2. Low frequency noise.

Low frequency turbine noise is the source of the SDR "thumping" sound mentioned in the majority of windplant noise complaints at Mars Hill and around the world. Low frequency noise travels much further through the atmosphere, an example being the rumble of distant thunder. The long drawn out rumble of distant thunder is produced by low frequency sound waves bouncing off the terrain and atmosphere, creating multiple echoes which reach the listener over a period of seconds, even though the initial event which caused the thunder, an instantaneous lightning flash, from close by was followed immediately by a loud high pitched crack and a loud explosion. From miles away the only sounds that remains of this short duration event are the lowest frequencies. All of the higher frequencies associated with the original sound have been attenuated by moisture, temperature, terrain and vegetation.

So it is with turbine noise. As shown in the Mars Hill noise study on virtually every graph

showing sound power levels by frequency band at the various monitoring locations the lower frequencies are much higher (Exhibit C), this despite the fact that the sound emitted by the turbines at the source contains louder noise in the higher frequencies. Table 7-1 Mars Hill noise study Dec. 2008 (Exhibit D)

3. Line source vs point source

The failure to use line source in the prediction model is another reason that Mars Hill turbine noise measurements exceed RSE's prediction by more than 10 decibels at some locations. The findings of fact on Stetson II and Rollins fail to acknowledge the concept of line source although in Rollins there was testimony submitted that should have been addressed in the findings of fact.

In his book *Wind Energy Comes of Age*, wind industry expert Paul Gipe explains line source:

Multiple turbines complicate matters further. From relatively long distances, an assembly of machines appears as a point source, and doubling the number of turbines merely doubles the acoustic power, increasing noise levels 3 dB. Closer to the turbines, they appear as a line source. The decay rate for line sources is 3 dB per doubling of distance, not 6 dB for true spherical propagation.

Paul Gipe's bio reads:

*PAUL GIPE is an internationally recognized authority on wind energy. After nearly two decades of working with wind energy, he has hands-on experience in nearly every aspect of the technology. Gipe has served as the West Coast representative of the American Wind Energy Association and as Executive Director of the Kern Wind Energy Association. In 1988 he received the American Wind Energy Association's highest honor for his contribution to the field. He has written two previous books: *Wind Energy: How to Use It* and *Wind Power for Home and Business*, both known for their frank, no-nonsense approach. He is a contributing editor to *Independent Energy* magazine and lectures widely on wind energy, both in the United States and abroad.*

The methods used to predict noise based on the source are the subject of an entire Chapter, #5 Sources, in Leo Barenok's seminal book, *Noise and Vibration Control*, first published in the 1960s, and republished many times as late as 2005. This is the textbook which all acousticians have studied from cover to cover while learning their profession.

As this authoritative "required reading" of the acoustics profession makes clear, there is no question that the use of multiple point sources, each decaying at 6 dBA per doubling of distance **is not** an academically, or professionally correct method to be used when a long row of multiple sources are focused on the receiver, which is the case for many of the protected locations on Roxbury Pond that have a line of sight relationship to most if not all of the turbines in the 3+ mile long string. In this instance line source modeling must be used with its corresponding 3 dBA decay rate per doubling of distance.

Additional research which uses Leo Barenek's classic mathematical constructions to evaluate turbine noise is found here:

NASA Technical Paper 3057 DOE/NASA/ 20320-77 1990
National Aeronautics and Space Administration
Office of Management
Scientific and Technical Information Division
Wind Turbine Acoustics

Harvey H. Hubbard
Planning Research Corporation
Hampton, Virginia
Kevin P. Shepherd
Langley Research Center
Hampton, Virginia

Work performed for U.S. Department of Energy
Wind/Hydro Ocean Technologies Division
and
Solar Energy Research Institute
Solar Technology Information Program
under Interagency Agreement DE-AI01-76ET-20320

Quoting from page 27:

Effect of Distance from a Single Row

Figure 7-26 shows calculated sound pressure levels for one row of the example wind power station, as a function of downwind distance for various rates of atmospheric absorption. Also shown are reference decay rates of -3 dB and -6 dB per doubling of distance. For an atmospheric absorption rate of zero, the decay rate is always less than that for a single point source (Figure 7-18). **At intermediate distances, the row of turbines acts as a line source, for which the theoretical decay rate is -3 dB per doubling of distance or -10 dB per decade of distance. Only at distances greater than one row length (900 m) does the decay rate approach the single-point-source value of -6 dB per doubling of distance (-20 dB per decade). Decay rates increase as the absorption coefficient increases.**

Richard Bolton, in his critique of the Mars Hill as built noise study conducted by RSE, and submitted to the Maine DEP on June 21, 2007 wrote:

4.2 Spherical Attenuation

RSE correctly states that sound diminished at 6dBA for each distance doubling. This is a result of simple geometrical considerations for a point source emitter and applies likewise to any similar emitter such as a light bulb. **However this is only true for a single emitter. For a long line of emitters the attenuation is not at a -6 dBA rate it is actually lower due to the cumulative addition of the adjacent emitters. This is elementary physics, see for example Feynman, (Ref. 13).**

Mars Hill project is a long line of emitters, see Fig. 9.

Fig. 9: Scale Drawing of Mars Hill turbine farm (from Ref. 1, Fig. 3.3) (not shown)

For a very long line of emitters the noise diminution becomes -3' dBA/doubling instead of -6 dBA. The emitters must be in phase, that is all the blades must be rotating synchronously with the blades in the same orientation among all turbines. The degree of phasing precision depends on the source frequency and at low frequencies the phasing becomes less demanding. Mars Hill's 28 turbines therefore will have an estimated attenuation coefficient of -4 to -5 dBA. This is for a consideration of simple atmospheric attenuation without other factors such as frequency dependent absorption and refraction/reflection effects. Nothing can be found in Cadna/A's documentation and the output plots do not show any characteristic alteration of iso-contour predictions that would be expected if these factors were included in their model.

I am not aware of any research that suggests that the sound propagation rules described above do not apply to wind turbines. If RHW LLC or Warren Brown are aware of such research it needs to be part of the record. The copy of the RSE map that I included with my previous testimony showing the corrected dB contours accurately reflects the proper use of line source modeling. I did not include the 5 dB penalty in the revised calculations on that map, but even without the penalty it is clear that 47 decibels or more will be experienced at most of the homes near Roxbury Pond on quiet nights when the turbines are operating near capacity due to sufficient wind above the ridge. Even if the wind is coming from the west, turbine noise below the ridge will encounter very little wind and attenuation of low frequencies will be minimal.

There is no room for compromise, or professional disagreement on this. Line source modeling is simply the correct way to do it and for any consultant to insist otherwise only proves that their goal is to get a permit for their client, or to ensure their continued employment with a department that is intent on issuing permits, using whatever means will justify the desired end result, rather than accuracy and truthfulness.

The failure of the DEP to enforce its own noise regulations due to political pressure and the notion that "poor" communities north of RT 2 do not deserve the same protections as more populated areas is a sad testament to the state of governmental affairs in Maine. The end result of the failure to require correct modeling procedures will be the repetition of the Mars Hill experience in community after community where turbines are permitted on ridges with quiet, rural communities in the valleys below, in clear line of sight to the turbines.

Additional discussion.

Many of the actions taken by Maine's government in response to global warming, including the adoption of S. 661, LD 2283, are based on the notion that climate change, although not completely understood, poses a threat that requires the use of the "precautionary principal", which essentially states that when an activity raises threats of harm to the environment or human health, precautionary measures should be

taken even if some cause and effect relationships are not fully established scientifically. In the enactment of S. 661, LD 2283, the sacrifice of important elements of Maine's "Quality of Place", its scenic mountain vistas, historically protected fragile mountain ecosystems, and the presence of vulnerable wildlife has been judged by the legislature to be necessary in order to take "precautionary measures" to combat climate change.

The LURC decision on Stetson II and the DEP decision on Rollins turn the precautionary principal upside down. Despite generally accepted scientific data about noise propagation modeling, and despite the presence of irrefutable proof that the prediction model for Mars Hill was flawed in its ability to predict harmful turbine noise, the State is taking the position that it can ignore that evidence and allow projects to be built, knowing full well that humans will almost certainly be subjected to noise in excess of the predictions and in excess of Maine's Noise Limits **as is happening daily at Mars Hill.**

Instead of requiring correct prediction modeling, which the Rollins decision states may cause the project to fail to meet Maine's nighttime noise law, the State instead is relying on the ability of the developer to address excess noise after the project has been built. This presumes that there are effective measures that can be taken to address excessive noise.

At Mars Hill, the windplant owner convinced the DEP that accurate prediction of noise levels was impossible due to the masking effect of surface winds and was given a variance based on this absurd claim, and then, even after turbine noise was found to exceed the limits established by the variance, a letter of compliance was issued which totally ignored the plight of the numerous families suffering from turbine noise well in excess of Maine Noise Limits. Without the use of mitigation methods that are available, but have been ignored in previous permitting processes, there is nothing, short of shutting down the turbines manually, that can be done to mitigate illegal noise at Mars Hill.

Unfortunately the turbines at Mars Hill are not equipped with automatic sensors which limit their operation when turbine noise levels exceed legal limits at protected properties and locations so there is no dependable mechanism in place to mitigate noise impacts. Had proper mitigation measures been required at Mars Hill no variance would have been necessary and no one would have complained about turbine noise, because the turbines would be controlled by appropriate sensors at appropriate locations which would reduce their operation when noise approached legal limits.

Here is what Wendy Todd said, without being asked, about the noise at Mars Hill today (4/28/09):

"It has been torturous here the last couple of days. The turbines have been brutal. It seems like a huge storm looming for days on end. I have days that I just don't know how to continue to live here. They get in your head, ears and chest and if you don't get a break you think you will go absolutely crazy."

The turbines proposed by RHW for Roxbury are going to inflict the same "torture" on Roxbury residents. Several homes on RT 120 in Roxbury are approximately the same distance from the proposed turbines as Wendy Todd's house is from the turbines on Mars

Hill. **"Brutality" and "torture" should not be the words used by Maine's residents to describe their experience of wind turbines. These words are not synonymous with "annoyance" as Dr. Dora Mills describes wind turbine noise impacts in the Rollins decision. But "annoyance" is also unacceptable. The word used to describe the sound of turbines should be "unnoticeable", especially at night.**

From the results of the post construction noise study at Mars Hill it is quite obvious that much higher than predicted turbine noise levels will occur at Roxbury Pond. The study may be found here:

http://www.marshallwind.com/UserFiles/File/regulatory_marshall/All_Q_Compilation_Report_Final_10-15-08.pdf

Figure 4-3 (Exhibit E) in the noise study shows turbine noise reaching 50 dBA averaged over one hour when wind speed at the receiver was zero during measurements in Dec. 2006 (blue diamond). Since there was no wind noise, and the narrative indicates "turbine noise prominent", it must be assumed that turbine noise was being measured. Figure 4-3 also shows turbine noise levels reaching 53+ dBA with wind speed below 12 mph, the speed above which useful measurements can no longer be made due to wind noise interference with microphone operation per Maine Noise Regulations. Clearly these measured levels of turbine noise exceed Maine's limits.

In Figure 3-11 (Exhibit F) the table shows that at a turbine power output of just above 700 kW the noise from the turbines averages 42 dBA during the 1QWT (blue diamond). According to Figure 3-1, the sound level of the GE turbine at this power output is approximately 98.5 dBA. The maximum sound level produced by the GE turbine is 104 dBA, or 5.5 dBA above the measured level of 42 dBA at 700 kW. This places the extrapolated turbine noise at 47.5 dBA, well in excess of Maine's already much too lenient 45 dBA nighttime limit, especially when keeping in mind the dBA measurements discount the low frequency thumping sound which is the source of the majority of wind turbine noise complaints.

Many of the ambient measurements in Figure 3-11 correlate with this assessment. At 1000 kW output, hourly averages of 42.5 and 43 dBA are measured during the 1QWT (blue diamond). According to the GE chart on Figure 3-1 the sound level of the GE turbine at this power output is approximately 100 dBA, 4 dBA below its maximum sound level. Adding 4 dBA to 42.5 and 43 dBA yields turbine sound levels of 46.5 and 47 dBA respectively, further proof of turbine noise levels exceeding Maine's Noise Limits at a distance of 1.1 miles from the turbines, a similar distance to the turbines from homes at Roxbury Pond. Note the model estimate at Mars Hill is approximately 8 dBA lower than these turbine noise measured levels. Although a variance was granted at Mars Hill, there is no justification for granting variances for any other wind energy facilities, including Record Hill Wind LLC when proper mitigation can be required by condition of any permit granted.

Whether these levels represent an average noise level, the maximum level, or some other

level is irrelevant. If noise propagation during the small window of time during which these measurements were taken can be found to exceed Maine's Noise Limits for dBA noise, there can be no permit issued, as the field measurements at Mars Hill, when applied to RHW LLC place the 45 dBA nighttime limit well beyond protected properties at Roxbury Pond.

The open topography of Roxbury Pond, the line source effect of multiple turbines in line of sight on a ridge to the east of the receiver and similar annual wind characteristics make it clear that if the GE 1.5 MW turbines were in use at Record Hill similar noise would be measured at a location similar to MP-2 at Mars Hill. Since Clipper Liberty turbines are proposed by RHW LLC which have similar if not slightly louder noise profiles, equal or greater noise levels can be expected at 6100' from the turbines on Flathead Mt. In fact, the entire shoreline of Roxbury Pond can be expected to receive noise in excess of Maine's Noise Limits due to the well known fact that ordinary conversations can be heard during quiet evenings from the other side of the pond. The hard surface of the water, combined with low wind and the layering of cool air at the surface, cause noise to travel long distances with little attenuation across the water during the evening. The RHW noise study does not address this "refractory" effect but its existence in this location is well known and must be recognized in the findings of fact.

A variance, if fully justified, should only be granted during the initial permitting process.

The letter of compliance granted to First Wind at Mars Hill following the post construction noise studies was an egregious effrontery to the many families at Mars Hill suffering from turbine noise. This unilateral act of the DEP in effect, nullifies Maine's legislated procedures and noise limits by agency fiat. If there is a reasonable expectation that RHW will exceed Maine's nighttime noise limits, the applicant should apply for a variance as part of the permitting process. The criteria for meeting the requirements of a variance demand that the applicant has taken all available steps to address the issue. The ability to control the turbines from remote sensors that turn them off when noise exceeds a threshold at carefully located receivers is of paramount importance and is a reasonable condition that must be imposed in any permit issued. By requiring the use of turbines that have such functionality a variance would not need to be granted either as part of the permitting process, or after the fact, since the turbines would automatically feather their props when conditions warranted and nighttime noise impacts to Roxbury's residents would be avoided.

In the Stetson II and Rollins decisions, post construction noise monitoring is required as a condition of the permit, but there is no mention of what, if any, steps would be taken when the monitoring indicates excessive noise, except that a compliance plan must be filed with the department. Without a discussion about what possible measures might be taken to reduce noise, one is left to presume that such measures exist. However, according to the American Wind Industry Association "Wind Energy and Noise" fact sheet (attached), the ability to control noise impacts relies mainly on the proper placement of turbines, and turbines on ridges with quiet pockets below require special attention. After the construction has occurred there is nothing that can be done to reduce noise levels except control the operation of the turbine so that it does not produce noise in excess of 45 dBA at

night, or 40 dBA if one applies the SDR 5 dB penalty as required by generally accepted acoustical engineering standards.

From the American Wind Industry Association "Wind Energy and Noise" fact sheet:

What can be done to reduce the likelihood of a noise problem from a wind project?

A noise analysis can be done based on the operating characteristics of the specific wind turbine that will be used, the type of terrain in which the project will be located, and the distance to nearby residences. Particular attention will need to be paid if residences are sheltered from the wind.

Comment:

There is no mention in the RHW noise study of the need to pay particular attention to the relationship between the turbines on the ridge and the homes at Roxbury Pond or along RT 120 even though the industry warns that such projects pose particular problems for noise transmission.

Also, pre-construction noise surveys can be conducted to find out what the normally-occurring background noise levels are at the site, and to determine later on what, if anything, the wind project has added to those levels.

Comment:

The most common method for dealing with a potential noise issue, as indicated above, is to simply require a "setback," or minimum distance between any of the wind turbines in the project and the nearest residence, that is sufficient to reduce the sound level to a regulatory threshold.

Some permitting agencies have set up noise complaint resolution processes. In such a process, typically, a telephone number through which the agency can be notified of any noise concern is made public, and agency staff work with the project owner and concerned citizens to resolve the issue. The process should include a technical assessment of the noise complaint to ensure its legitimacy.

Comment:

This process has not proved useful to Mars Hill residents and there is no reason to believe that, absent the ability to control the turbines with remote wind or noise sensors, there is anything useful that the windplant owner can do.

*In general, wind plants are not noisy, and wind is a good neighbor. **Complaints about noise from wind projects are rare, and can usually be satisfactorily resolved.***

Comment:

Complaints about noise from wind projects are not rare, they are in many cases prohibited.

Landowners who lease their land are required to sign leases which prohibit complaints about noise, as is the case with the lease between RHW and Bayroot/Wagner. Since the people who are most likely to be impacted by turbines, those living with turbines on their property, are legally enjoined from complaining, large numbers of victims are silenced by the industry.

Complaints at Mars Hill have been loud and ongoing since the day the first few turbines were activated. Dr. Michael Nissenbaum has conducted interviews with the families who have been impacted by the noise of Mars Hill turbines. The Power Point Presentation of his findings is attached. To summarize:

Since the wind turbines began turning in December 2006, 93% of those interviewed experience sleep disturbance, 60% 5-7 times per week, 87% to a degree that they have consulted a doctor. 53% have increased headaches, 40% newly onset. 20% experience dizziness, and 20% unusual body sensations (2 subjects reported chest pulsations, 1 pulsatile ear pressure). 33% are troubled by shadow flicker: 2 subjects experience nausea and dizziness, 2 dizziness only, and 1 migraines. 33% have gained weight, and 1 subject has lost weight.

73% have feelings of stress, 87% anger, 40% anxiety, 27% irritability, 73% hopelessness, and 53% depression (7 out of 8 new, and 1 subject increased). The anger can be extreme, as evidenced in comments such as: "Absolute rage — you feel you want to kill someone" (67-year-old woman) and "So angry I could kill" (65-year-old man). Hopelessness is also deep: "Nobody will help us"; "No options — can't leave, and can't live here"; "People don't believe us"; "No one cares. No one listens"; "It's very hard watching my child suffer". Two women and 2 men (27%) were tearful at points during their interviews.

20% received new prescriptions for depression, and 1 subject's existing depression medication was increased. 20% were newly diagnosed with hypertension, and 1 subject's blood pressure worsened; all were offered new or increased medication, and 3 of the 4 subjects accepted.

100% agreed that their quality of life has been affected, with comments such as: "Loss of joy in living ... put a lot of life's plans on hold"; "No desire to go outside"; "Feel trapped"; "Dreams have been dashed"; "We have no peace and quiet"; "My husband's [who has advanced MS] only pleasure in life was to see the wild animals. They are gone"; "No sleep": "Sinking feeling every night when I [come home] and see them".

100% have considered moving away, and 73% can't afford to. For 90% of the homes (8 out of 9), loss of home value by recent appraisal makes it impossible to move away.

Dr. Nissenbaum has submitted his study to the New England Journal of Medicine and a peer reviewed article about turbine noise and health effects at Mars Hill and elsewhere is likely to be published in the near future.

Yale University has investigated the noise complaints at Mars Hill and is in the process of

designing a scientific study of the health impacts that Mars Hill neighbors are experiencing.

In the Rollins decision, Dr. Dora Mill's at CDC is reported to have testified, *"In reviewing noise concerns generally associated with wind turbines, the Maine Center Disease Control (MCDC) within the Department of Health and Human Services commented that, according to a 2003 Swedish EPA review of noise and wind interference and **noise-induced hearing loss is not an issue when studying the of noise from wind turbines as the exposure levels are too low.** The MCDC states that it finds no evidence in peer-reviewed medical and public health literature of adverse health effects from the kinds of noise and vibrations associated with turbines other than **occasional reports of annoyances.** Most studies on the health of noise have been done using thresholds of 70 dBA or higher outdoors, much than what is seen in wind turbines. With regard to sleep disturbance, the World Health Organization (WHO) guidelines for community noise recommend that outdoor levels in living areas for nighttime not exceed 45 dBA, which is consistent with law."*

No one to my knowledge is claiming that wind turbine noise causes hearing loss. Dr. Mills' statement suggesting that hearing loss is a concern, in itself is proof that MCDC is not informed about wind turbine noise issues. None of the respondents to Dr. Nissenbaum's interview listed hearing loss as a concern. Wind turbines cause sleep deprivation, hopelessness, despair, anxiety, rage, depression. These impacts and the complaints that result rise to a level of medical urgency far above "occasional reports of annoyance". The failure of MCDC to find evidence in peer-reviewed medical and public health literature of adverse health impacts only proves that MCDC did not look very hard. There are far more studies documenting the negative impacts of wind turbine noise than studies proving no adverse impacts as MCDC claims. The absence of rigor on the part of MDEC, especially when presented with evidence by the medical community that turbine noise is known to be a serious medical problem for people at Mars Hill, is astonishing and shows an appalling lack of regard for the health of Maine's citizens.

The World Health Organization recommends 30 dBA in bedrooms for sleeping. Maine's nighttime limit of 45 dBA will allow 40 dBA to enter bedrooms through open windows in the summer. Furthermore, as is well known and documented by George Kamperman, low frequency turbine noise can actually penetrate the walls of homes, creating louder apparent turbine noise inside than outside due to the quieter ambient levels in a bedroom compared to outside the home. Mars Hill residents report this phenomena as mentioned earlier.

How the sound levels at Roxbury are predicted is of utmost importance. The use of a complex computer model such as RSE used for RHW obscures some very obvious facts. The turbines on Record Hill ridge are in line of sight to many of the protected locations near Roxbury Pond. Sound will travel in a straight line to these locations, uninterrupted by terrain or vegetation. A very simple chart using the principals discussed above regarding SDR 5 dB penalty and line source noise propagation, and including an atmospheric attenuation factor based on temperature and humidity being within the normal range for Roxbury can demonstrates quite readily what the computer model obscures. (Exhibit H) Note that Clipper Liberty 2.5 MW turbines are louder than the GE 1.5 MW

turbines at Mars Hill. Also note that Clipper Liberty turbines are not equipped with the controls needed to allow for remote control operation from data from noise or wind sensors, so another brand will be required. Specifications for any substitution must be made available for review prior to approval by the DEP.

In summary, RHW must be required to use the correct assumptions and modeling methods in its noise prediction calculations. The 5 dB penalty for SDR noise and the appropriate use of line source effects must be incorporated into a revised statement of the predicted noise levels from this project. Recognition of the persistence of low frequency noise even when higher frequencies have been attenuated by the atmosphere is essential to the protection of Maine's communities. Any permit issued must contain a condition that remote control of the turbines by the use of appropriately sited noise or wind measuring equipment is required, and will be accepted as a mitigation measure that will not be contested by the operator so that the turbines will not emit noise that exceed the nighttime noise limits at any protected properties or locations.

Please include a discussion of these issues and findings of fact with regard to these issues in the draft decision and any final order.

Respectfully submitted,
Steve Thurston

Figure 7-17.

Sample Time History Plots for Positions MP-1 and MP-1A (2 of 2)

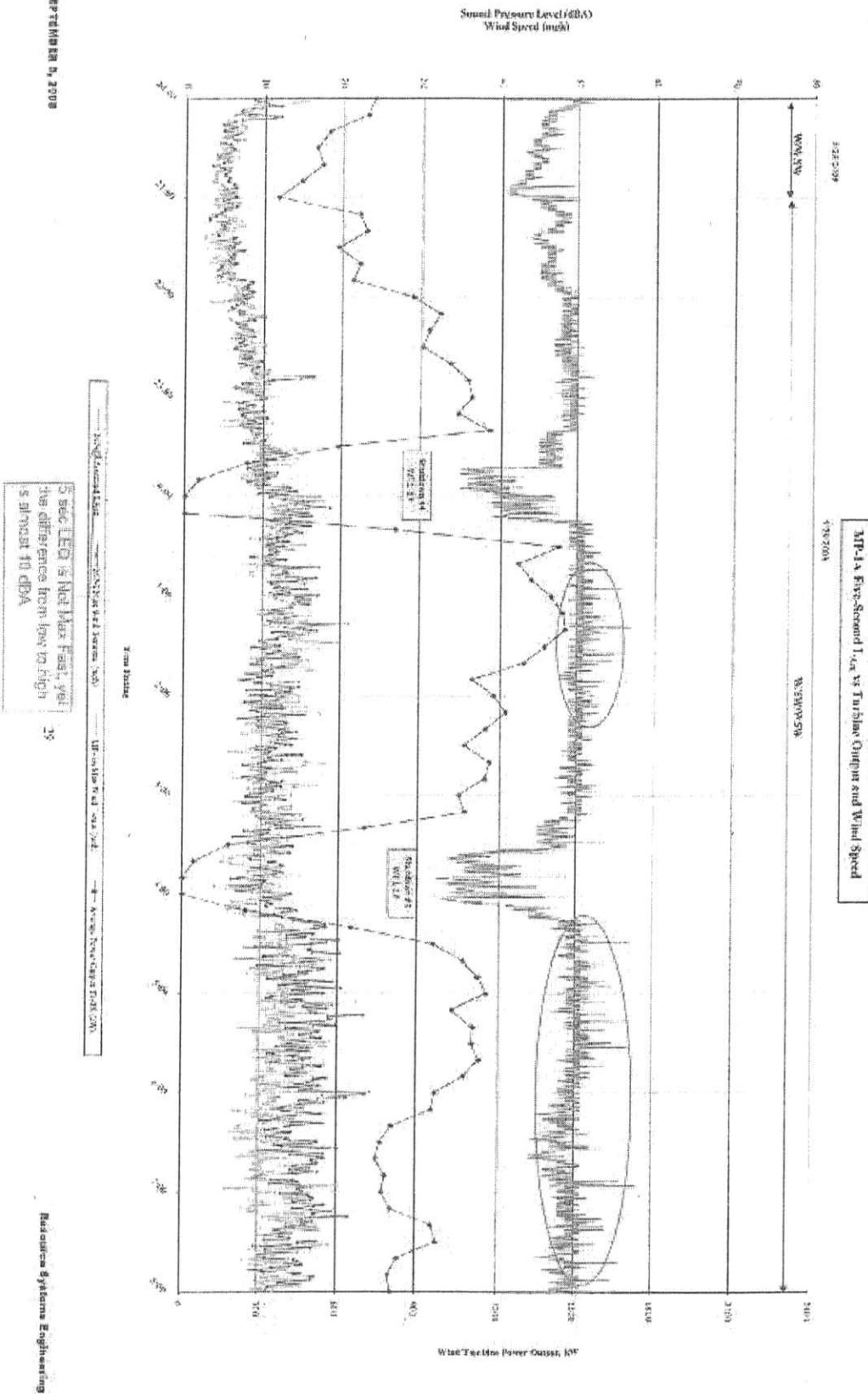
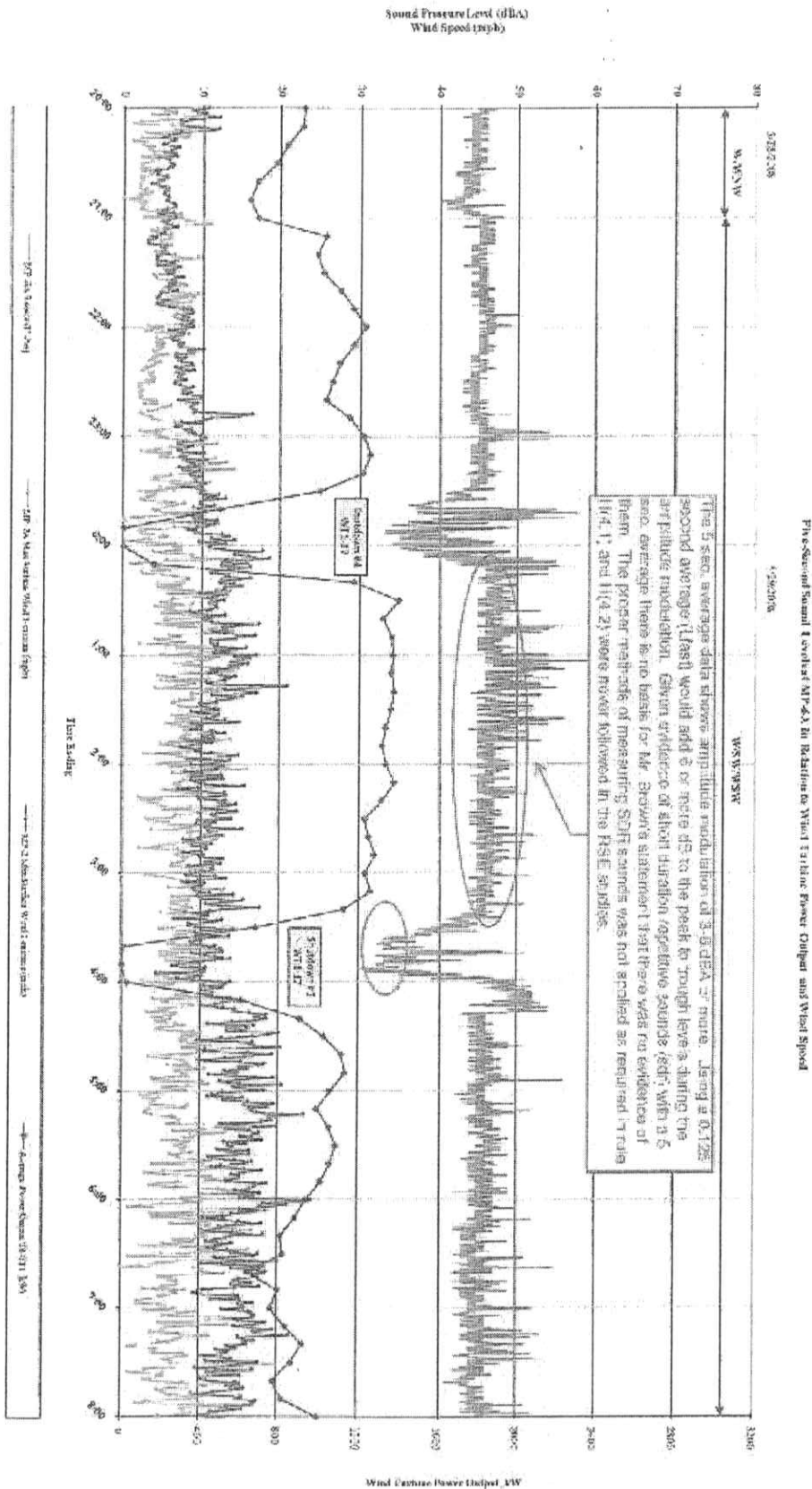


EXHIBIT A



Mars Hill Sound Study w Appendices.pdf (120 pages)

MP-43
11-May-07 7:13 to 2:21

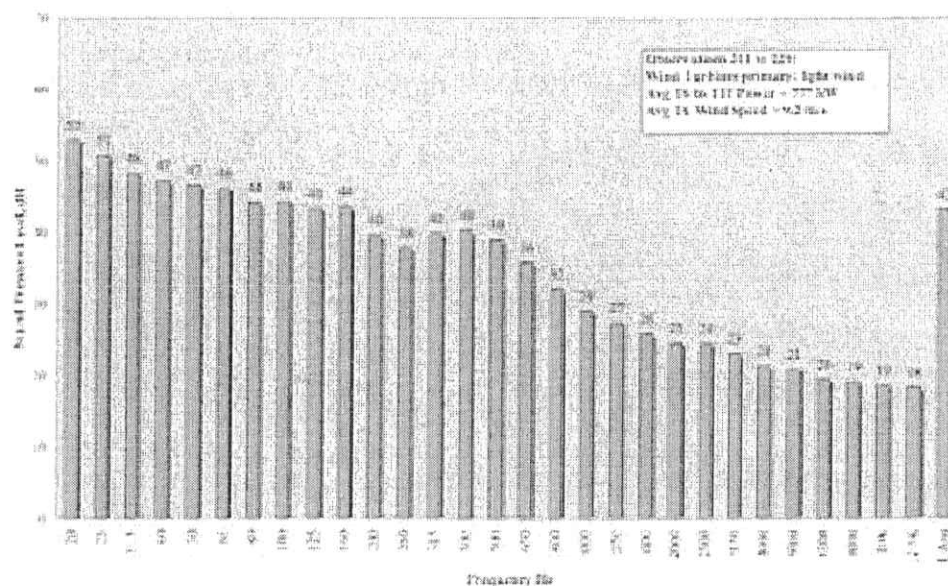
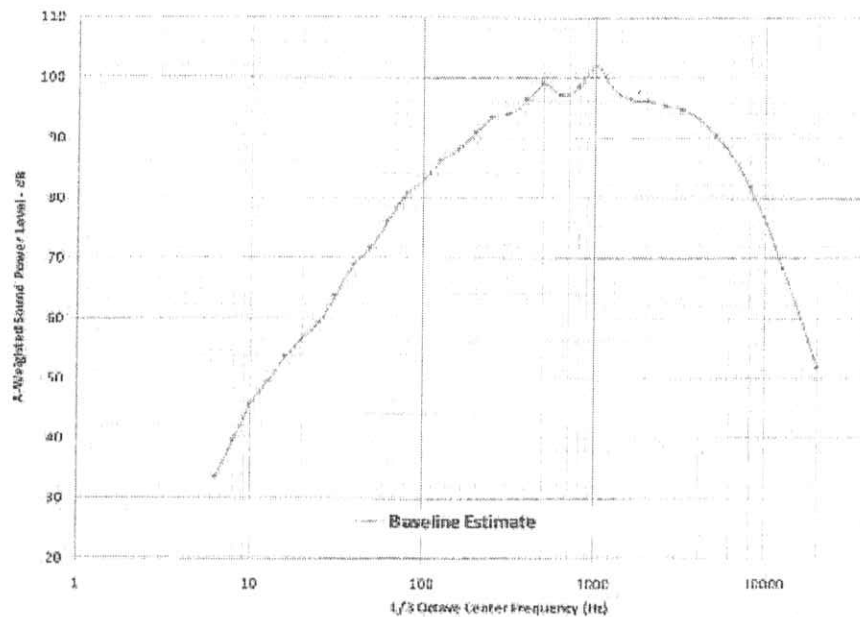


TABLE 7-1 WIND TURBINE SOUND POWER LEVELS (Wind Speed = 12.6 m/s at turbine hub)			
3rd Octave Band Center Frequency, Hz	Sound Power Level, dBA	Octave Band Center Frequency, Hz	Sound Power Level, dBA
50	71.6		
63	76.1	63	82.4
80	80.8		
100	83.2		
125	86.3	125	91.1
160	88.1		
200	90.9		
250	93.5	250	97.8
315	94.1		
400	96.3		
500	99	500	102.4
630	97.1		
800	98.5		
1000	102	1000	104.7
1250	98.2		
1600	96.3		
2000	96.1	2000	100.7
2500	95.4		
3150	94.8		
4000	93.1	4000	97.9
5000	90.3		
6300	86.9		
8000	81.7	8000	88.3
10000	75.7		
SUM	108.6	SUM	108.6

Source: Clipper C96 Specifications, July 30, 2008

Figure 7-2.

Clipper C96 Estimated A-Weighted Sound Power Level -
Baseline Air-Cooled Generator
LWA = 108.63 dB(A)



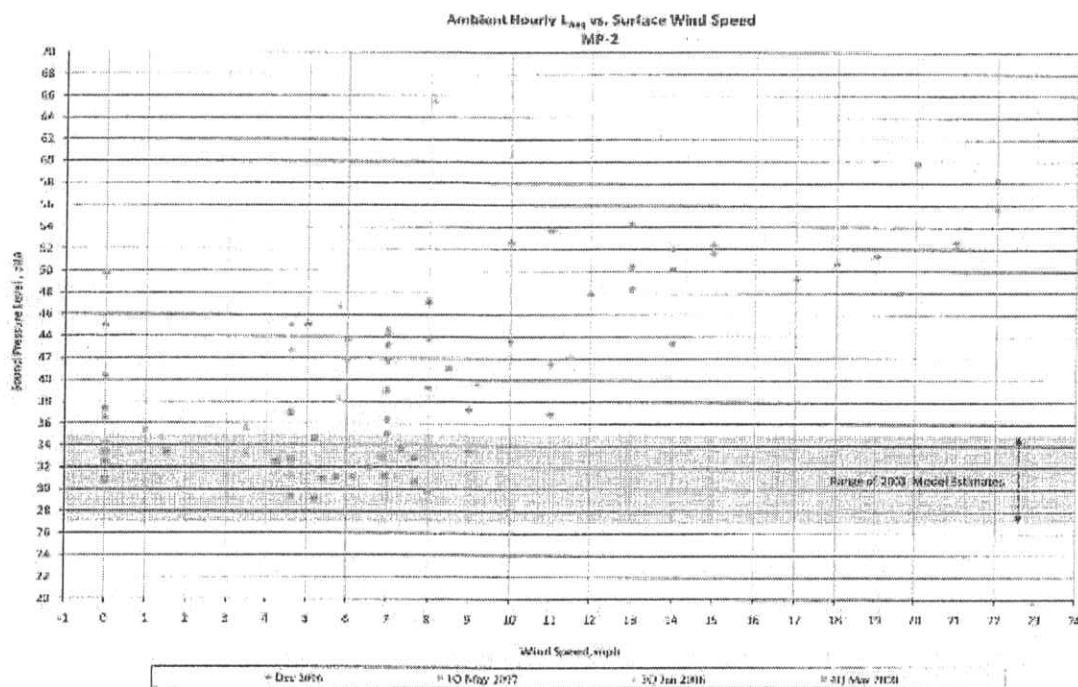


Figure 4-3. Ambient Hourly Sound Level at MP-2 in Relation to Surface Wind Speed

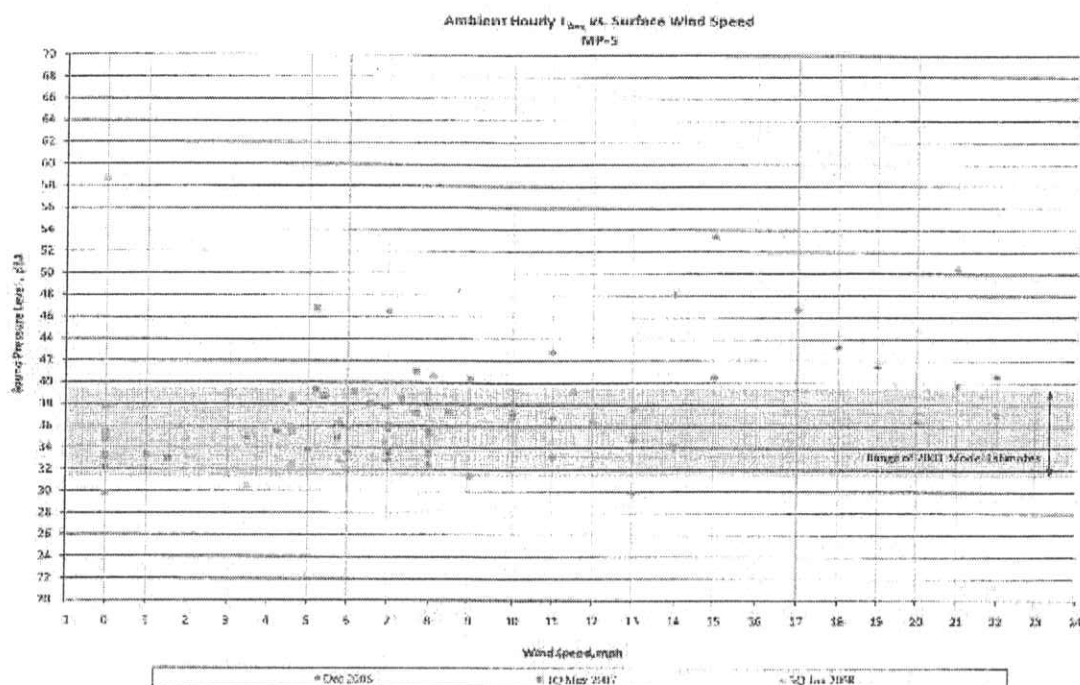


Figure 4-4. Ambient Hourly Sound Level at MP-5 in Relation to Surface Wind Speed

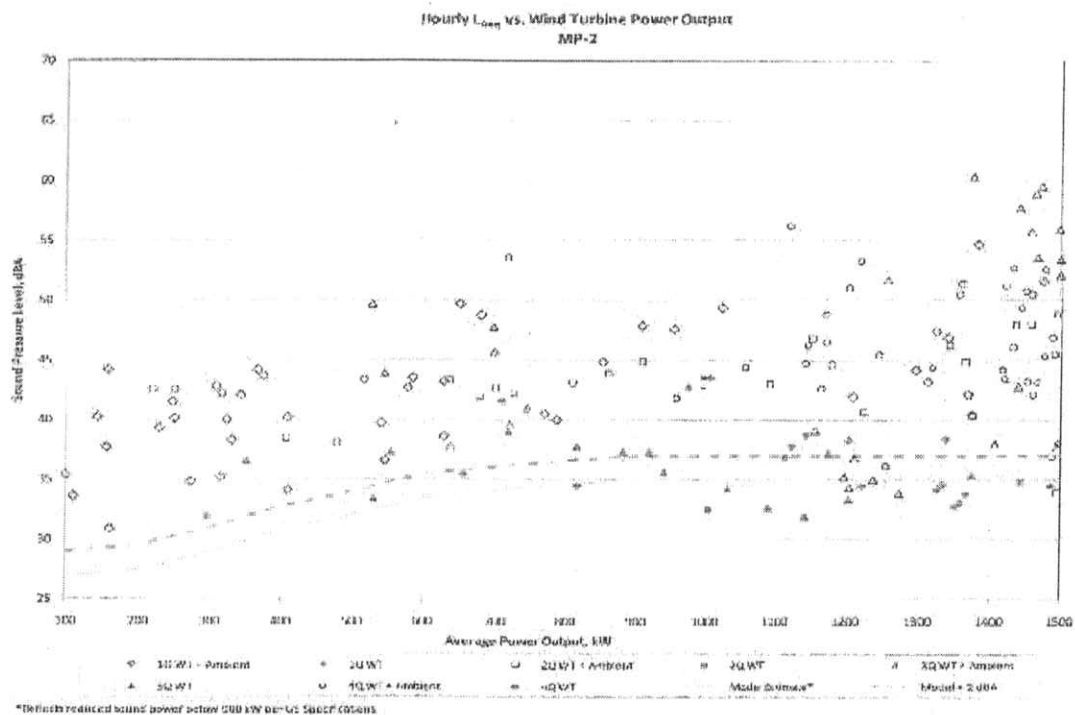


Figure 3-11. Correlation between Hourly L_{Aeq} Measurements at MP-2 and Average Power Output of Wind Turbines 10 through 15

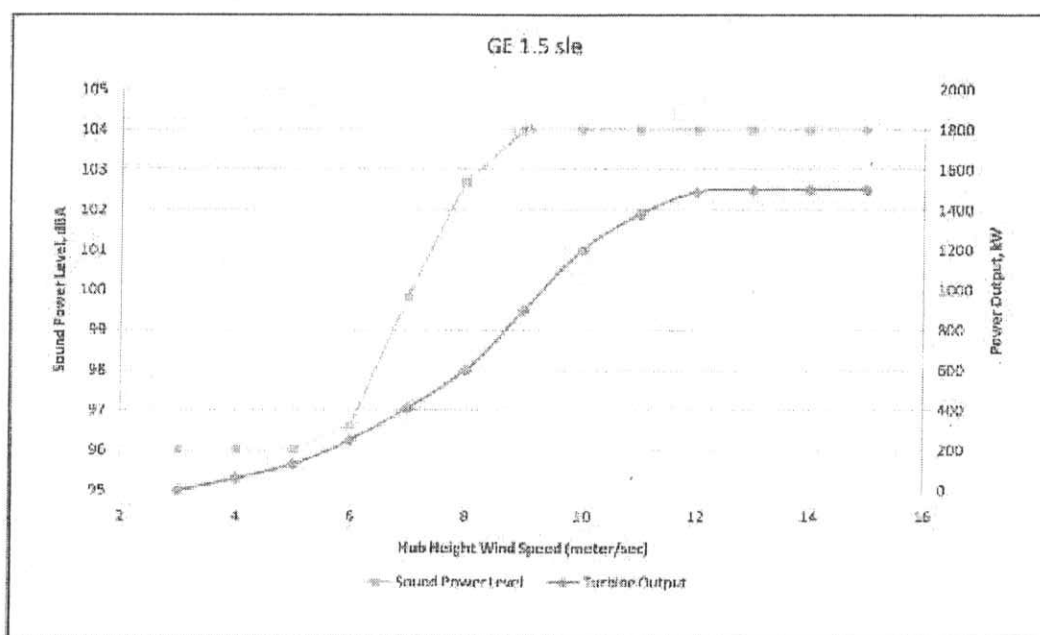
Figure 3-11 shows a consistent distribution of hourly L_{Aeq} measurements around the model estimates for periods when sound from wind turbines was prominent (as indicated by solid colored symbols). Measurements indicated by the open symbols indicate periods when wind turbine sound was not prominent due to high surface wind conditions or low levels of wind turbine operation due to light upper level winds. In addition to sound from wind turbines, these measurements include a significant or prominent contribution of non-turbine, ambient sound. During high surface winds, measured sound levels above 55 dBA were generally caused by sounds from wind forces acting on vegetation (tree tops) and terrain and were not attributable to sound from wind turbines.

For a more effective representation of wind turbine sound levels, Figure 3-12 plots the measured hourly L_{Aeq} values for all four rounds of quarterly testing for only those periods when wind turbines were observed to be a prominent contributor to measured sound levels. The data points are plotted against a curve of the 2003 model estimates extended to reflect reduced sound power output of the turbines below 60% power generation.

3.0 COMPILATION OF QUARTERLY TEST RESULTS

The results of all four rounds of quarterly operations testing have been combined and are presented in graphical format by monitoring position. The following provides a description, aerial mapping and photo for each monitoring position where quarterly data has been compiled. The graphs plot measured wind turbine sound levels in relation to the average power output of the nearest five or six wind turbines depending on their relationship to the monitoring position. Measured sound levels are plotted for all hours of measurement when the average power output from nearby turbines was at or above 100 kW. These nearby turbines are the primary contributors to wind turbine sound at a monitoring position. This sound level contribution fluctuates with the average power output of those turbines.

The measurement results are plotted against a curve showing the predicted sound level versus turbine power output. This curve is derived from the 2003 sound level prediction model with resulting sound level adjusted to reflect the turbine sound/power curve as shown in Figure 3-1. The sound power/output curve reflects turbine performance specifications. The curves indicate that maximum sound output occurs when wind turbine output reaches or exceeds 60% of rated power. During these routine operations the turbine rotor reaches its maximum rotational speed (or rpm). As shown by Figure 3-1, the sound power level remains constant from 60% to 100% of rated electrical power output.



*Excludes Uncertainty Factor of ± 2 dBA per GE Technical Documentation – Noise Emission Characteristics (2004) and Confidence Level of ± 2 dBA per GE Technical Specification – Noise Emission Compliance, GE Wind Energy, May 2005.

Figure 3-1. Sound Power Level and Power Output of GE 1.5 MW Wind Turbines in Relation to Wind Speed at the Hub Height

The graphs presented for each station indicate by symbol and color the measurement results for each round of quarterly testing. Measured sound levels under weather and operating conditions when sound from the wind turbines was prominent are indicated by solid-colored symbols. For all four rounds of quarterly testing, these periods were determined based on statistical parameters, field observations, surface wind data, plus turbine operating and hub wind speed data. Symbols with no fill are for

Wind turbine noise decrease with distance

miles	feet	meters	3 dB decrease		6 dB decrease	
			Line Source		Point Source	
			Clipper Liberty 2.5 MW		5 dBA SDR penalty applied	
0.001	3.28	1			114	
0.001	6.56	2			108	
0.002	13.12	4			102	
0.005	26.25	8			96	
0.010	52.49	16			90	
0.020	104.99	32			84	
0.040	209.97	64			78	
0.080	419.95	128			72	
0.159	839.90	256	66		66	
0.318	1679.79	512	63			
0.636	3359.58	1024	59.7			
1.273	6719.16	2048	56.4			
1.695	8949.00	2731	55.1			
2.117	11179.00	3412	53.8			
2.545	13438.32	4096	52.5			

At this distance point source becomes line source equal to the spacing between the turbines, approx 800'

Notes

1. 2731 meters and 3412 meters are interpolated
2. Attenuation factor of .3 dBA per 1000 meters @ 100 HZ 50% humidity 20 degree in order to capture the low frequency thumping noise attenuation accurately